has been conspicuously lacking elsewhere in Australia, which brings me to my final comment.

6. *education and scientific responsibility.* Australia's scientists have been conspicuously silent on the environmental and conservation problems facing the nation. There are many reasons for this including fear of losing jobs or research support, an aversion to communicating in simple language with the public or in dealing with the media, and the way scientists are trained. Scientific training in Australia is highly specialized with little or no exposure to the humanities and emphasizes communication with other scientists at the expense of communicating with the lay public. Scientists are trained to rely on facts and not to go beyond their experimental results. As a consequence, most scientists are not very good at making predictions or getting involved in social or environmental issues where predictions are needed and the data base is incomplete. Far from being virtues, these attributes of Australian scientists make it too easy for them to be captured by vested interests and manipulated by ill-informed and scientifically illiterate politicians.

The results are a lack of understanding within the community of the importance of research and education for the betterment of the nation and the prevalence of uninformed debate and conflict on environmental issues within the media and between environmentalists, government and developers. Australia's scientific community has a much more important role to play. Until more scientists are prepared to speak up and to explain their findings to the public, progress in wildlife conservation will be hesitant and largely ineffectual as measured, not by today's wildlife scientists, but by future generations of Australians who will inherit a much poorer land.

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# Reserve selection in New South Wales: Where to from here?

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## INTRODUCTION

In the previous issue of this journal, John Whitehouse presented an historical perspective of the development of the reserve system in New South Wales and its underlying rationale (Whitehouse 1990). For several decades, the notion of representativeness has been an explicit goal of reserve selection in this state. The National Parks and Wildlife Service and the authorities which preceded it have recognized that the reserve system should represent the full range of the state's biophysical diversity, whether this diversity is defined by geology, geomorphology, species, vegetation types or those ill-defined entities called ecosystems (see Strom 1979 and annual reports of the Service). The same fundamental goal is a basis for conservation efforts internationally (e.g., IUCN 1980) and is stated in the National Conservation Strategy for Australia (Anon. 1984). Whitehouse makes two important points about the achievement of this goal in New South Wales, which apply equally well to other states and other countries: first, the apparent adequacy of the reserve system and the areas selected for new reserves depend very much on the way in which biophysical diversity is defined; and, second, progress towards a fully representative reserve system is less direct when opportunism replaces a more systematic programme for reserving natural features. The issues of a suitable data base and a systematic procedure for reserve selection deserve much more discussion and are explored further in this article.

### *Data Bases for Reserve Selection*

Ideally, the data base for biological conservation would consist of comprehensive information on the distribution, abundance and habitat requirements of all the species and infraspecific variants in a region. In reality, such information is never available when decisions on the

locations or reserves are made and is approximated in only very few regions. In most regions, the best information for reserve selection and assessments of the impacts of developments consists of a map of land classes (vegetation types, land systems etc.) and a list of species considered to warrant particular attention because of rarity and/or threat.

Biological conservation is therefore generally approached in two ways: with information on land classes and information on species. Although the two types of information can lead to quite different priorities for reservation (Whitehouse 1990), they are, in fact, complementary. The need to use both arises from the practical advantages and limitations of land classes in guiding reserve selection.

Land classes such as vegetation types, geological units or land systems are used as surrogates for information on individual species because they are much more easily derived and more widely available. They allow reserve systems to be structured in a way which we assume is better, in terms of representing species, than allocating reserves randomly or according to the tenures most easily converted from other land uses; but how useful are they in this regard?

It is a common assumption that the great majority of species will be protected by reserving land classes (e.g., MacKinnon *et al.* 1986). The Nature Conservancy of the USA has even suggested that reserving plant communities could protect 85% of species (Hunter *et al.* 1988) but there appears to be little basis for such estimates. Reserve simulations on floristic vegetation types suggest that the figure can be much lower and depends greatly on the scale of definition of the land types (Pressey and Bedward, in press). The question of which types of land classification are the best bases for species conservation has received no attention. In practice, reserve selection is generally based on the scale and type of classification which happens to be available, although new mapping has been undertaken specifically for some reserve planning exercises (e.g., in the Victorian mallee by Parkes and Cheal 1987).

Even an estimate as high as 85% of species represented by reserving land classes recognizes that land classes are heterogenous in terms of species occurrence and that representing all classes in reserves is likely to leave many species unreserved. This recognition led to the dual approach to biological conservation of the US Nature Conservancy described by Noss (1987). In his terms, reserving land classes is a "coarse filter" strategy which efficiently represents a large proportion of species but must be complemented by a "fine filter" or species-specific strategy for conserving those which slip through.

Such an approach makes good sense, given the types of information generally available for reserve selection, and has been widely applied in Australia and elsewhere, though with different terminologies. Although the idea is attractive, it has a major limitation: the species which fall through the "coarse filter" cannot be confidently identified without the prohibitively expensive and time-consuming surveys which make land class reservation a practical necessity. It seems unlikely that these species will all be the same as those defined, *a priori*, in lists of rare or threatened plants and vertebrates. For example, in the Western Division of New South Wales which occupies about 320 000 square kilometres or 40% of the state, 35 species of Rare or Threatened Australian Plants (ROTAPs) occur (Briggs and Leigh 1988). It would be unwise to assume that all of the other approximately 1 600 native plant species in the region would be adequately represented in a reserve system based solely on land classes. Other species in the region are also rare, even if not fitting the categories for ROTAP and the patchy distributions of some of the more common ones might lead to their under-representation in reserves unless they are specifically targeted. Nevertheless, such lists of "special" species are useful for the "fine filter" approach. They define species which are most vulnerable to depletion or extinction and which are least likely to be represented adequately or at all by land class reservation. They should not, however, be assumed to dovetail neatly with land classes as a basis for a fully representative reserve system.

### *The Benefits and Costs of Opportunism*

The Scientific Committee on Parks and Reserves was established in 1968 to turn the goal of representativeness into recommendations on a system of reserves (Whitehouse 1990). This was not the first recognition of the need for a fully representative reserve system by a nature conservation authority in the state. In 1949, the Fauna Protection Panel was established with the aim of reserving all of the state's natural systems. Despite this explicit goal and at least a broad picture of biodiversity, one of the Panel's leaders later stated that "the pattern of faunal reserve dedication which subsequently emerged was unfortunately a scramble for whatever was offering" (Strom 1979). Reservation after the Scientific Committee's reports and the Specht Report on the reservation of Australia's plant communities (Specht *et al.* 1974) was also dominated by opportunism, with the timing and priority of investigations and dedication being significantly influenced by factors such as the proposed disposal of leasehold and vacant Crown land, the sale of properties of interest, and the emphases of the non-government conservation organizations (Hitchcock 1981; Whitehouse 1990).

Such opportunism has been a major influence on the increase in reserve area in New South Wales (Whitehouse 1990) and is attractive for two reasons: first, with hard competition between conservation and alternative land uses, any situations which facilitate reserve dedication are welcome; and, second, if such situations are not exploited, the areas involved are likely to be committed to other uses or have their conservation values destroyed.

On the other side of the balance sheet, there is a price to be paid for these benefits. This was succinctly put by Whitehouse (1990) who stated that "a reserve expansion programme fashioned on opportunism may at best contain gaps and distortions or at worst be misdirected with high opportunity costs and although brimming with aesthetic and emotional appeal be fundamentally lacking in scientific logic".

Some recent research on computer-based reserve planning has allowed the costs of opportunism to be quantified. Newly developed algorithms for reserve selection are directed specifically at the goal of representativeness. They are designed to identify the minimum set of sites (properties, wetlands, forest fragments etc.) needed to represent all the biophysical features, however defined, in a region. This minimum set is the starting point for developing a fully representative reserve system. The algorithms show that the total areal cost of representing all features is higher when the analyses begin by including the existing reserves than when the existing reserves are not necessarily included (Margules 1989; Pressey and Nichols 1989a; Pressey and Nicholls in press; Pressey *et al.* in press). These results can be expressed graphically, as shown by data from preliminary reserve selection trials by Pressey and Nicholls (1989a) for northwestern New South Wales (Fig. 1). This analysis was based on land systems, the most detailed and consistent definition of natural environments in the region. The overall rate of accumulation of land systems in a nominal reserve network using the unconstrained algorithm, which ignores the existing reserves, is virtually the highest possible — all 128 land systems represented at least once in 7 980 square kilometres. In contrast, the accumulation curve for the existing reserve network is considerably lower, containing a total of 36 land systems in 4 611 square kilometres. The accumulation curve for the constrained algorithm, starting with the existing reserves, is shifted laterally, representing all land systems in an overall total area of 11 503 square kilometres. Using properties as units of acquisition, this is now the minimum area in which all natural environments in the region can be represented.

There are two reasons for the flatness of the actual accumulation curve and therefore the lateral displacement of the best achievable (constrained) curve: the initial acquisitions for the three existing reserves were not optimal in terms of the number of land systems represented per unit area; and, more importantly, Sturt National Park was greatly enlarged with little gain in land systems represented (see flat section of actual accumulation curve in Fig. 1).

The same comparison can be plotted as a temporal trend (Fig. 2). In 1971 there were no reserves in the region and the algorithm could have selected reserves occupying 5.7% of the region to represent all land

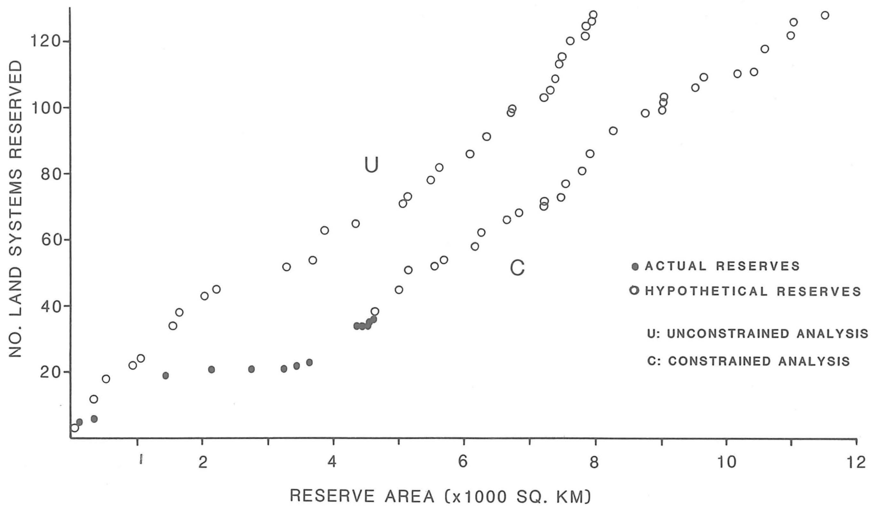


*Figure 1.* Accumulation of natural environments in actual hypothetical reserve systems in northwestern New South Wales.

systems. In 1988, opportunistically selected reserves occupied 3.3% of the region. Starting with and including these reserves, the algorithm required 8.3% of the region to represent all land systems, i.e., additional reserves totalling 5.0% of the region were necessary. The relatively small contribution of the existing reserves to complete representation is clear: the two lines are almost parallel.

The results of these analyses, as indicators of the value of the existing reserve system in the region, require some qualification, however. The unconstrained accumulation curve was never achievable and nor is the constrained curve achievable now because the properties involved are very unlikely to become available when required. Compromises will be necessary between the value of sites for representation of natural environments and the availability of these sites. These compromises will tend to flatten the theoretical curves shown. In addition, there are sound biological arguments for the enlargement of reserves, and therefore flattening of the accumulation curve, after initial gazettal. Finally, the comparisons in the figures are based only on the presence of absence of land systems in reserves and not on their proportional representation. Similar comparisons based on the representation of a minimum proportional area of each land system are planned as soon as the algorithm has been altered accordingly.

Despite these qualifications, there is an urgent need for more rigor in the initial selection and subsequent enlargement of reserves in the Western Division and elsewhere. The comparisons in Figures 1 and 2 are more than clear hindsight. A continuation of opportunism in reserve selection and enlargement will further increase the total cost of reserving all natural environments and could well exhaust the options for reservation before the reserve system is fully representative. Extrapolation of the average rate of accumulation of new land systems in the existing reserves suggests that a total area of 16 400 square kilometres or 11.8% of the region will be needed to opportunistically represent at least one occurrence of every land system. This is without consideration of minimum proportional representation of land systems, the reservation needs of species missed or under-represented by land class reservation and the additional areas required to link and buffer formal reserves.

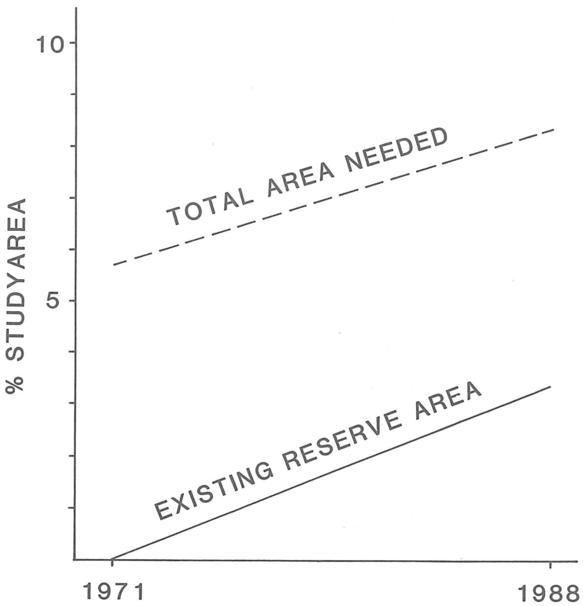


*Figure 2.* Actual reserve area in northwestern New South Wales compared to the total area required to represent all natural environments.

There is much scope for initial reservations in an area and subsequent enlargements of reserves to be more systematic and to contain more natural diversity, even in the face of real-world constraints. Minimum set algorithms have much to offer in this respect. They can establish a strong case for a fully representative network of reserves by demonstrating what is required, whether the individual parts are purchased for conservation or, at the very least, protected from clearing or other gross disturbance. They can aso be used in guiding decisions on conservation alternatives. Comparison of the optimum result from the algorithm with the results of constraints introduced by planners can clearly demonstrate the implications of these constraints, both in terms of the specific sites involved and the overall area required to represent all the natural diversity in a region. Examples of constraints include extending an existing reserve rather than establishing a new one elsewhere, requiring that a reserve be located adjacent to another across a state border, and excluding some areas from consideration because of poor condition and inappropriate location.

There are, of course, alternatives to these algorithms for systematic reserve selection. Multi-criteria scoring procedures allocate values to sites according to various cirteria such as diversity, rarity, size and naturalness and combine the scores into an overall index of conservation value or priority (see Margules and Usher 1981; Smith and Theberge 1986; Usher 1986 for reviews). However, this approach has an important disadvantage. If reservation proceeds from the top of the list downwards, a very large proportion of the sites can be necessary to represent all the natural features of a region (Pressey and Nicholls 1989b). Such a reservation strategy results in much duplication of relatively common features without representing the less common ones (Margules *et al.*, in press). The minimum set algorithms minimize this problem by

selecting networks of sites which best complement each other in terms of the features they contain.

Apart from the efficiency of sampling environments or species in reserves, flexibility in designing a conservation strategy is an important factor in achieving a fully representative reserve system. Three important factors influence where lines are drawn on a map to indicate desired reserves: the definition and knowledge of natural features to be reserved; assumptions about the best way of representing them; and information on the availability and condition of alternative sites. If any one of these is changed, then the map of the conservation strategy is out of date. Another advantage of minimum set algorithms is that they can be used to quickly update the reservation scenario when more information on rare species becomes available, the required representation of each map unit is changed, a reserve is dedicated on the border of an adjacent state and a contiguous one becomes a priority, or the information on clearing or condition is reviewed.

## CONCLUSIONS

The likelihood of conserving all the remaining natural environments and native species in the state is decreasing rapidly as clearing, woodchipping and other land uses reduce biodiversity and limit the choices available for reserving it. Achievement of this goal depends not only on improving the data base on the features to be reserved but, just as importantly, on developing rigorous procedures for selecting reserves.

Primary needs for improving the data base for reserve planning are mapping natural environments, surveying the distribution and abundance of species, and researching their habitat requirements. Given that reservation based on land classes will continue to be a practical necessity in many regions, research is also needed on ways of using this information to maximize the representation of species in reserves. Issues which need to be addressed include the cost-effectiveness of mapping at different scales for species reservation, the proportion of species represented when reserves are based on different types of land classes, and the characteristics of species which are missed when reservation is based only on land classes. These are all spatial considerations. Reserve selection and design should also rest on knowledge of short- and long-term population dynamics and their implications for retaining species represented in reserves.

Sensible decisions on the data base to be used for reserve selection or even competent mapping and surveys to improve the available information do not guarantee a representative reserve system. The methods of using this information in selecting reserves has a major effect on the actual sites proposed, the features they contain and the likelihood of ever protecting all the natural environments or species in a region. The attractions of an opportunistic approach to reserve selection come with a considerable cost, not only in northwestern New South Wales but in other states and countries. Systematic scoring procedures also have limitations in representing biophysical diversity. Minimum set algorithms avoid the problems of these alternatives and, although requiring further development and trials, will increase the likelihood of achieving the goal which underlies conservation efforts in New South Wales and elsewhere.

In Tasmania, 22.5% of land is reserved and another 14.5% listed on or nominated for the Register of the National Estate but additional areas must be protected to fully represent biological diversity (Brown and Hickey 1990). These authors consider that the conservation debate in Tasmania has concentrated on wilderness value and other factors at the expense of biological conservation. Few other states or countries will have the option of considering the need for further reserves when more than 37% of their areas are already protected in some way.

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# National Parks and Wildlife: Nature conservationists or political puppets?

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I can't help wondering if John Whitehouse believes the propaganda he disseminates or whether he has been entrenched in the heirarchy of the New South Wales National Parks and Wildlife Service (NPWS), dominated by the political influences of the day for so long that he has lost the ability (if he ever had it) to realistically assess the performance of the Service.

I have yet to see any indication that the Service has ever been progressive or proactive in nature conservation. Not even the management of segments of the estate has changed substantially in its history. For example, philanthropic groups of citizens still administer State Recreation Areas. A nucleus of the present band of trustees has been around since the days of Lands Department ownership. Although decreasing in numbers in recent years, they retain a significant and far reaching influence within the Trust system, generally peddling their anti-conservation attitudes.

The "impressive record" in obtaining 4.62% of New South Wales has little to do with the efficiency of the Service. It has largely been a result of outside forces. In this State, the bushwalking fraternity was the first major lobby group and this group formed the nucleus of the early conservation lobby. It is this combined lobby that must bear the responsbility for preservation of a large proportion of the NPWS estate. An indication of their influence can be seen in the large tracts of prime bushwalking habitat in the national parks system, with associated scenic views and mature forests, while biologically productive areas such as estuaries and wetland are conspicious by their absence.

It seems that it is more by accident than by design that reserved areas contain "islands" providing a variety of habitats and consequently significant biodiversity. As Whitehouse points out, the ecosystems acquired which are of world heritage standing was also accidental.

If any one attitude pervades the whole of the system, it is one of "freeze-frame". Emphasis has been placed on acquiring "climax" areas and locking them in time. If one is really interested in nature conservation, areas in a variety of "successional phases" are required, not simply pristine forests that are asthetically pleasing.

Showcases of representative ecosystems with isolated gene pools, identified on the basis of macro-floristic components, will be of little value with the onset of climatic shifts bought about by the greenhouse effect. What is urgently required is a proactive approach to gain corridors and areas large enough to encompass refugia for the maximum numbers of species, incorporating the whole range of wildlife — not just mature trees and furry animals.

Time may have already run out.